OROVILLE FACILITIES RELICENSING
(PROJECT NO. 2100)

SP-F2, PHASE 1 INTERIM PROGRESS REPORT

SP-F2. EVALUATION OF PROJECT EFFECTS ON FISH DISEASES

REVIEW DRAFT

PREPARED FOR:
Oroville Facilities Relicensing
Environmental Work Group

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Initial Progress Report for Oroville Fish Disease Study (F2)

Phase 1 Interim Progress Report for SP-F2, Evaluation of Project Effects on Fish Diseases

BACKGROUND

The overall objective of the study is to evaluate the effects of ongoing and future Project operations (pump-back operations, hatchery production, water temperature, etc.) on the establishment, transmission, extent and control of infectious hematopoeitic necrosis virus (IHN), bacterial kidney disease (BKD), and other significant coldwater and warmwater fish diseases. Significant diseases are those diseases that can cause serious losses to Feather River basin fish populations through increased direct, or indirect, mortality. Additionally, the study will establish tools to evaluate future potential operational scenarios and other protection, mitigation and enhancement (PM&E) measures.

This study includes two-phases: a literature review and desktop study (Phase 1) and field surveys (Phase 2). The first phase (Phase 1) of the study will entail a literature review (Task 1) to determine the presence and prevalence of endemic and introduced fish diseases in the Feather River Basin. This study plan will focus on significant fish diseases of highest management concern in the region, including IHN, BKD, and ceratomyxosis. This review will identify the documented disease outbreaks in these waters, the life history characteristics of the causative agents, mechanism of disease transmission, disease outbreak timing and duration, and control methods. A history of impediments to fish passage and fish transplants in and upstream of the Project and their origin (i.e., rearing facility) will be included to provide a comprehensive disease summary. The data collected in Phase 1 also will serve as a foundation for development of potential future protection, mitigation and enhancement measures (PM&Es).

In Task 2, data will be gathered on Project operations, including Feather River Hatchery (FRH) practices, and their influence on water temperatures, other relevant water quality parameters, and parameters significant to the spread and control of fish diseases. This information will be combined with the analysis from the first task to evaluate how Project operations, including hatchery production and release practices, might affect the establishment, extent and control of diseases and documented outbreaks. Results will be organized to address: (1) the impact of reservoir diseases, (2) reservoir-hatchery interactions, and (3) the impact of reservoir and hatchery diseases on Feather River fish downstream of the Fish Barrier Dam and upstream Project waters, including potential to pass diseases upstream past Big Bend Dam during high water years. Throughout the process, data gaps will be identified. Recommendations for minimizing potential Project impacts on the establishment and transmission of fish diseases will be provided for use as tools in developing potential future PM&Es related to hatchery operations

If significant data gaps are identified in the available knowledge base and indicate that significant potential risk exists, Phase 2 will consist of developing and implementing field studies to investigate specific Project effects on diseases in Project waters and obtain information that will be useful for developing potential future PM&Es. A decision to implement Phase 2 will require consultation with the Environmental Workgroup.

TASK 1—PERFORM LITERATURE REVIEW AND GATHER DATA OF DISEASE PRESENCE.

Actions Taken

This study commenced on September 25, 2002. This literature and data collection and review task is ongoing.

As a first step in our data gathering effort, MWH staff and Eric See of Department of Water Resources (DWR) met with Dr. Scott Foott of the United States Fish and Wildlife Service (USFWS) on 9/25/02 and with Dr. Bill Cox and Ms. Anna Kastner of California Department of Fish and Game (CDFG) on 9/26/02. The intent of both meetings was to gather information from these local experts that may be otherwise unavailable in reports. We discussed potential fish pathogens that may be present and pathogens that have a history of occurrence in the Project waters (Table 1). We identified infectious haematopoietic necrosis (IHN) and ceratomyxosis as the two significant diseases with respect to Project operation and the Feather River Basin. These diseases were determined significant due to their presence in Project waters or at FRH, potential or exhibited virulence, and the potential to be influenced by Project operations.

MWH also has initiated collection and review of available data and information related to diseases in the Project waters. We have obtained pathology and hatchery annual reports from the Feather River Hatchery and have compiled relevant literature pertaining to significant fish diseases. A bibliography of the collected literature is attached.

Status of Specific Objectives under Task 1

- Determine the occurrence and distribution of significant diseases in Project waters, including IHN, ceratomyxosis, BKD, cold water disease, and whirling disease – 50% complete
- Evaluate the potential for diseases to spread downstream in the Feather River (Task 1) – 20% complete.
- Document the life history characteristics of the causative agents of the significant diseases and the mechanisms of disease transmission – 10% complete
- Document methods of controlling significant diseases – 0 % complete.
- For each significant disease, identify salient environmental conditions that impact disease transmission, e.g. high water temperatures - 10% complete.
- Catalog historical and current fish species found within the Project area and evaluate their susceptibility to diseases - 0% complete.

TASK 2—EVALUATE PROJECT'S IMPACTS ON FISH DISEASES FROM LITERATURE REVIEW

Actions Taken

No separate actions have been taken under Task 2.

Status of Specific Objectives under Task 2

- Evaluate the effect of hatchery operations on disease transmission within the study area - 0% complete.
- Evaluate whether disease outbreaks in the study area may result from pumpback operations because of fluctuating environmental characteristics – 0% complete.
- Evaluate the prevalence and potential for disease outbreak in the study area from current Project operations – 0% complete.
- Review environmental characteristics of Project waters (i.e., from SP-F3.1, SP-F3.2, and SP-F10) to identify areas of management concern with significant potential for disease outbreaks or disease transmission –0% complete.

Preliminary Findings

Disease management is a normal component of every aquaculture program. Although most fish diseases originate (Oliver 2002) and/or are maintained in wild fish populations (Amos and Thomas 2002), diseases are not easily observed or detected in the wild. The operations and environment of fish culture facilities allow for full disclosure of disease outbreaks because symptomatic and dead fish are somewhat protected from predators and are easily observed in this contained environment. At FRH some disease concerns have been addressed by the installation of an ultra violet water treatment system, modifications to the stocking of Lake Oroville, periodic pathological testing, as well as prescribed use of common treatments. The FRH has been successful in managing fish diseases and continues to operate as a productive and successful hatchery that contributes to the recreational and commercial fisheries in California.

IHN

IHN is likely the most significant fish disease presently in the Feather River Basin. The causative agent of IHN, infectious haematopoietic necrosis virus (IHNV), is common in both free-ranging and cultured salmonid stocks in the West (La Patra *et al*. 2001). In California IHNV is present in Central Valley and Trinity River anadromous salmonids, IHNV was once common in cultured fish in California, but since the statewide adoption of egg disinfection with iodophor solutions (~1990) has rarely been seen in hatcheries. The specific strains of IHN found in California have been isolated from Chinook salmon and typically have not been transmitted to steelhead (personal communication from Scott Foott, USFWS California-Nevada Fish Health Center). In the mid- to late-1990s, two unique strains of IHN, FR Type 1 and 2, were isolated from adult Chinook salmon returning to the Feather River Hatchery (personal communication from Dr. Bill Cox, CDFG). In 2000, DWR fisheries biologists observed Chinook salmon that were symptomatic of IHN while conducting a snorkeling survey between the Feather River Hatchery and Live Oak and collected wild Chinook salmon that later tested positive for FR Type 2. CDFG staff suspected that either this strain of IHN was extremely virulent or that heavy stocking of Chinook salmon in Lake Oroville was resulting in conditions that allowed for amplification of the virus. The stocking of Chinook salmon in Lake Oroville was dramatically reduced in 2000 and completely eliminated in 2001 due to the detection of virus positive adult Chinook in the lake and concerns for hatchery and wild salmonids below the lake. In 2001, FR

Type 2 was isolated from juvenile steelhead at Feather River Hatchery (personal communication from Dr. Bill Cox, CDFG).

The available evidence regarding transmission of fish diseases suggest that wild fish populations are the natural hosts and reservoirs of infection and that there is not high risk of IHN transmission from hatchery to wild fish populations (Amos and Thomas 2002). This was recently confirmed for the Nimbus strain of IHN found at Coleman National Fish Hatchery in the upper Sacramento River basin. In a study conducted by the USFWS California-Nevada Fish Health Center (Foott *et al.* 2000), Chinook salmon collected from wild populations were exposed to IHN infected hatchery fish for different time intervals, but failed to demonstrate horizontal viral transmission. These findings were consistent with other studies assessing risk of IHN transmission (LaPatra *et al*. 2001).

Data Gaps Identified

During the initial review of information on IHN, we identified several areas where information is currently unavailable. These data gaps are listed below; the degree to which these gaps are related to the Oroville relicensing effort has not yet been determined.

1. Is the IHNV, FR Type 2 strain, more or less virulent than the Nimbus strain and to what degree does it pose a risk to wild populations of Chinook salmon and steelhead in the Feather River?

2. Is the FR Type 2 strain found within other areas of the state?

In association with SP-F9, Evaluation of the Feather River Hatchery Effects on Naturally Spawning Salmonids, Dr. Hedrick of University of California, Davis may be conducting basin-wide research on IHNV. This study effort could include establishing a strain typing baseline from trout and salmon in hatcheries and natural populations throughout California. This effort would contribute information pertinent to data gap #2. Dr. Hedrick's studies could also entail laboratory experiments that would begin to assess the virulence of the new strains of IHNV, data gap # 1.

Ceratomyxosis

Ceratomyxosis was first observed in 1948 in fall spawning rainbow trout from Crystal Lake Hatchery, Shasta County, California (Wales and Wolf 1955). Ceratomyxosis is a disease of significant concern although both Feather River Chinook salmon and steelhead show some resistance (greater for Chinook salmon than steelhead) to this disease. The causative agent of ceratomyxosis, *Ceratomyxa shasta,* is endemic to the Feather River basin and is present upstream of the Feather River Hatchery in the North Fork and Lake Oroville (personal communication from Dr. Bill Cox, CDFG). Ceratomyxosis is lethal to many strains of rainbow trout.

The poor success of CDFG efforts at stocking rainbow trout in Lake Oroville in the 1970s and 1980s are thought to be due, in part, to the prevalence of the infective stage of *C. shasta* in the lake. The progression of ceratomyxosis is influenced by water temperature. In general, mortality associated with *C. shasta* increases as water temperature increases above 50^{o}F although the relationship may be more complicated. For example, in some southwest Washington streams

C. shasta has been documented to be infective at temperatures below 43 ^{o}F (Harza 2000). In addition, recent temperature trials conducted by the USFWS California –Nevada Fish Health Center in the Klamath basin showed that at high level of pathogens mortality could be 100% regardless of temperature (personal communication from Scott Foott, USFWS California-Nevada Fish Health Center).

The DFG currently operates a popular put-and-take trout fishery in the Thermalito Forebay (DWR 2001). Rainbow trout and brook trout are the primary species stocked. Although no fish are planted into the Thermalito Afterbay or Diversion Pool these three water bodies are hydrologically connected. Because there is no passage barrier, fish stocked into the Forebay move freely into the Diversion Pool. Rainbow trout have also been collected from the warmer and shallower Afterbay that presumably came from the Forebay via the Thermalito Pumping-Generating Plant.

The FRH has experienced periodic fish losses due to *C. shasta*, although steelhead can be successfully held at the hatchery on untreated water without incidence of disease (personal communication from Anna Kastner, CDFG). To help control mortality from ceratomyxosis, the FRH uses ultra violet water treatment system. In one episode, FRH experienced steelhead and rainbow trout losses to *C. shasta* when fish at the Thermalito Annex were held on Afterbay water (personal communication from Dr. Bill Cox, CDFG). CDFG staff have expressed concern over ceratomyxosis in Project waters above the FRH and have theorized that conditions in the Thermalito Complex, including the warmer water in the Afterbay and the stocking of susceptible rainbow trout in the Forebay, may be creating an environment favorable to *C. shasta.*

Data Gaps Identified

During the initial review of information on IHN, we identified several areas where information is currently unavailable. These data gaps are listed below; the degree to which these gaps are related to the Oroville relicensing effort has not yet been determined.

1. Does the stocking of rainbow trout in the Thermalito Forebay increase transmission of *C. shasta* to hatchery and wild salmon, steelhead and rainbow trout populations located downstream?

2. Does the operation of the Thermalito complex (for example, pump back operations, increased temperature of the Thermalito afterbay) increase the transmissibility of *C. shasta* to steelhead, salmon and rainbow trout populations downstream?

The literature review and assessment of project effects that will occur during Phase 1 of this study will address the data gaps identified for ceratomyxosis.

Table 1. Potential Fish Diseases Present in the Oroville Project Waters.

Disease	Pathogen
Infectious Haematopoietic Necrosis (IHN)	Infectious haematopoietic necrosis virus
Ceratomyxosis	*Ceratomyxa Shasta*
Bacterial Kidney Disease (BKD)	*Renibacterium salmoninarum*
Furunculosus	*Aeromonas salmonicida*
Enteric Red Mouth (ERM)	*Yersinia ruckeri*
Whirling Disease	*Myxobulis cerebralis*
Proliferative Kidney Disease (PKD)	*Tetracapsula bryosalmonae*
Rosette Agent	Undescribed
Infectious Pancreatic Necrosis	Infectious pancreatic necrosis virus
Gill Maggot Disease	*Salmincola californiensis*
Cold Water Disease	*Flavobacterium psychrophilum*
Columnaris	*Flexibacter columnaris*
Epistylis (Red Sore Disease)	*Epistylis sp.*

Table 2. Potential Fish Diseases for consideration in this study.

Disease	Pathogen
Enteric Septicemia of Catfish (ESC) (potential)	*Edwardsiella ictaluri*
Edwardsiella Septicemia (potential)	*Edwardsiella tarda*
Iridovirus (potential)	*Lymphocystivirus*
Sturgeon Herpes Type 2 (potential)	White Sturgeon Herpes Virus Type 2

Oroville Project F-2 Bibliography (updated 10-17-02)

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